

**FINAL  
PHASE II (a) FIELD SAMPLING PLAN FOR  
TRENCHES, PITS, EXCAVATIONS, BUNKERS, FORMER  
BUILDINGS, AND GROUND SCARS**

**OF THE  
CAMP EDWARDS IMPACT AREA  
GROUNDWATER QUALITY STUDY**

**MASSACHUSETTS MILITARY RESERVATION  
CAPE COD, MASSACHUSETTS**

Prepared for

**NATIONAL GUARD BUREAU  
ARLINGTON, VIRGINIA**

Prepared by

**OGDEN ENVIRONMENTAL AND ENERGY SERVICES  
239 Littleton Road, Suite 1B  
Westford, Massachusetts 01886**

Jonathan Bourne Public Library

19 Sandwich Rd.

Bourne, MA 02532

# Final Phase II (a) Trenches FSP

---

## DISCLAIMER:

This document has been prepared pursuant to a government administrative order (U.S. EPA Region I SDWA Docket No. I-97-1019) and is subject to approval by the U.S. Environmental Protection Agency. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency.

# Final Phase II (a) Trenches FSP

## TABLE OF CONTENTS

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
1.1 DESCRIPTION OF FEATURES .....	1
1.1.1 Description of Bunkers .....	3
1.1.2 Description of Ground Scars .....	4
1.1.3 Description of Pits and Excavations.....	6
1.1.4 Description of Trenches.....	7
1.1.5 Description of Former Buildings .....	8
<b>2.0 PROPOSED SOIL INVESTIGATION .....</b>	<b>8</b>
2.1 SAMPLING LOCATIONS .....	9
2.1.1 Ground Scar 7 .....	9
2.1.1 Ground Scar 8 .....	9
2.1.2 Ground Scar 9 .....	9
2.1.3 Pit 1.....	9
2.1.4 Excavation 2 .....	10
2.1.5 Bunker 1 (CS-19) and Cleared Area.....	10
2.2 SAMPLING & ANALYSIS METHODS FOR SOILS .....	10
<b>3.0 SAMPLE IDENTIFICATION .....</b>	<b>12</b>
<b>4.0 REFERENCES.....</b>	<b>13</b>

### *Tables*

Table 1. Summary of Feature Types and Locations .....	2
---	---

### *Figures*

Figure 01. Locations of Trenches, Ground Scars, Excavations, and Bunkers with 1943 photo.....	14
Figure 02. Locations of Trenches, Ground Scars, Excavations, and Bunkers with 1955 photo.....	15
Figure 03. Locations of Trenches, Ground Scars, Excavations, and Bunkers with 1966 photo.....	16
Figure 04. Soil Sampling Arrangement at Target Buoy (GS-7).....	17
Figure 05. Proposed Soil Investigation for GS-9.....	18
Figure 06. Proposed Soil Investigation for EX-2 .....	19
Figure 07. Proposed Soil Investigation at BK-1.....	20
Figure 08. Proposed Soil Investigation at GS-8. ....	21
Figure 09. Proposed Soil Investigation at Pit 1. ....	22
Figure 10. Plan of Soil Sampling Grid .....	23



*Attachments*

Attachment A. Regulatory Agency Comments and Responses on Draft Trenches FSP ..... 24

Attachment B. Photographs of Reconnaissance Locations..... 31

Attachment C: Field Guide to High Explosives ..... 35

Attachment D. Soil Sampling Protocol ..... 38



Digitized by the Internet Archive  
in 2013

<http://archive.org/details/finalphaseiiafi00unse>

# Final Phase II (a) Trenches FSP

---

## 1.0 Introduction

This Field Sampling Plan (FSP) was prepared in accordance with the approved Final Workplan for Phase II (a) Activities (Ogden, 1999a). The features that are the subject of this FSP were among areas identified by EPA as part of the locations to be investigated in Phase II (a) of the Impact Area Groundwater Study (IAGS). The various features combined in this FSP, including trenches, pits, excavations, bunkers, former buildings, and ground scars, are located within the Impact Area. The features were originally identified in the Environmental Research, Inc. (ERI) Aerial Photographic Site Analysis (May 1994). ERI labeled these features observed in the aerial photographs based on their color, tone, shadow, texture, size, shape, pattern, and association. Ogden assigned each feature a name using ERI's label combined with a unique number in the Draft Range Use History Report (Ogden, 1997). These same names are used in this FSP.

Trenches, pits, excavations, bunkers, and buildings that are not included in this FSP include those features identified in Ogden (1997) that were located in the J Ranges, and buildings located near Pew Road that were associated with tear gas training. The J Range features will be addressed in the workplans to be developed for those areas in accordance with the Phase IIa Workplan. Tear gas training activities are among those activities addressed in the Draft Training Areas Workplan (Ogden, 1999b).

A draft version of this FSP was provided to the regulatory agencies for review in October 1999. Comments on this FSP were received from EPA and MADEP, and responses to comments submitted in November 1999. The comments and responses are included in Attachment A of this FSP.

## 1.1 Description of Features

Between August 17 and 28, 1999, a field reconnaissance of various features identified by the EPA as locations to be investigated was conducted. Coordinates of the various locations to be investigated were derived from aerial photographs where the features were visible, using electronic versions of the photos in the Geographic Information System (GIS). The coordinates were entered into a hand-held Global Positioning System (GPS) unit and used in the field. Once located, the area of each feature was described in a field logbook and photographed. A second field reconnaissance was conducted on November 10, 1999 to identify a possible trench located on the west side of Turpentine Road.

# Final Phase II (a) Trenches FSP



Each of the locations to be investigated, covered by this field sampling plan, are listed in Table 1 and described below. Photographs referenced below are provided in Attachment B. The features are broken down into the following categories:

- Bunkers
- Ground Scars
- Pits and Excavations
- Trenches

The reconnaissance also included features located in the J Ranges and buildings located near Pew Road that will be included in the Phase IIa plans for those areas. These features are not considered further in this FSP. Note that the only former buildings included in this FSP are bunkers, as these were the only buildings identified in the Impact Area. Buildings associated with military ranges and training areas outside the Impact Area are being addressed in the J Range workplans, Training Area workplan, and Phase II (b) workplans.

Table 1. Summary of Feature Types and Locations

Location Identification	Location Type	Location Coordinates	Photograph Number
BK-1	Bunker	70 32 39.526 41 42 48.820	20
BK-2	Bunker	70 31 59.041 41 42 06.299	1
BK-3	Bunker	70 38 15.863 41 42 23.900	2
BK-4	Bunker	70 33 09.834 41 42 18.552	3
GS-2	Ground Scar	70 31 38.441 41 43 03.873	4
GS-3	Ground Scar	70 31 31.960 41 42 57.968	5
GS-4	Ground Scar	70 31 24.758 41 42 58.544	6
GS-5	Ground Scar	70 31 21.878 41 42 57.536	7
GS-6	Ground Scar	70 31 10.931 41 42 54.367	8
GS-7	Ground Scar	70 32 18.708 41 42 57.738	9
GS-8	Ground Scar	70 32 03.358 41 42 19.428	10
GS-9	Ground Scar	70 31 52.268 41 42 05.025	11

## Final Phase II (a) Trenches FSP



Table 1. Summary of Feature Types and Locations

Location Identification	Location Type	Location Coordinates	Photograph Number
GS-10	Ground Scar	70 32 09.408 41 42 01.220	12
PIT-1	Pit	70 32 11.136 41 42 42.125	13
EX-1/GS-1	Excavation	70 33 03.131 41 42 38.380	14
EX-2	Excavation	70 32 27.412 41 43 06.322	15
TR-2/3	Trench	70 32 13.955 41 42 59.866	16
TR-4	Trench	70 32 10.128 41 42 58.688	17
TR-5	Trench	70 32 36.197 41 42 59.204	18
Turpentine Road	Trench	See Figure 3	NA

NA – Trench could not be effectively photographed from the ground due to heavy vegetation.

The locations of features described in this plan are illustrated in Figures 1-3. These three maps show the extent of features over one or more years, using aerial photos from 1943, 1955, and 1966. The existing wells and existing soil sampling grids on these maps are from the IAGS Phase I investigations. The proposed monitoring wells on these maps are the locations proposed in the RDX Response Plan (Ogden, 1999d).

### 1.1.1 Description of Bunkers

Bunkers are reinforced concrete structures built into the side of a hill and covered with soil and vegetation, which are used as a sheltered observation point. Four bunkers were identified by ERI in the 1943 and subsequent aerial photographs. All four of the bunkers were located during field reconnaissance activities. Bunker 1 (BK-1) from the Ogden and ERI reports is located at CS-19 and is not included in this FSP, as indicated above. The other three bunkers are shown in Figures 1 through 3 and described below.

BK-1 (CS-19 Bunker, photo 20): This bunker is located approximately 600 feet north of the CS-19 access road and faces north. The access road to this bunker is still clear of heavy vegetation. The dirt floor and concrete walls show little damage. The door and portions of the walls around the door were blown off exposing rebar. The area above and behind the bunker is littered with illumination canisters, mortar fins, and metal debris. The area around the bunker has impact craters, pits, burn marks, and a distinct lack of vegetation. Historic photographs show a cleared area to the south of the bunker. This

# Final Phase II (a) Trenches FSP

---

cleared area is now overgrown with vegetation (photo 19) but the vegetation type is different from the surrounding area.

BK-2 (photo 1): This bunker is located off of Wheelock Road in a fairly flat area. The bunker appears to have been built and then covered with soil and vegetation. The concrete bunker has a dirt floor. The bunker faces the north. No targets are visible from the bunker. There is no evidence of waste disposal or stressed vegetation in or outside the bunker. There are no signs of detonation in the area. There is no debris in the area.

BK-3 (photo 2): Bunker 3 is built into the side of an existing, east facing slope. It was most likely used to view mortar targets located across the Succonsette Pond kettle hole. There is no evidence of waste disposal or stressed vegetation in or outside the area of the bunker. The area is very heavily vegetated.

BK-4 (photo 3): Bunker 4 also faces mortar targets located east of Succonsette Pond. It is located southeast of Bunker 3, deep in the brush. The dirt floor and concrete walls do not look damaged in any way. There is no evidence of waste disposal or stressed vegetation in or outside the bunker. The former road to the bunker is heavily vegetated and mostly unrecognizable.

## 1.1.2 Description of Ground Scars

The ERI report describes ground scars as small cleared areas with unknown origin or function. Many of the ground scars, which appear in the 1943 and subsequent aerial photographs, are no longer visible. Some of the areas have burn marks on older trees. Twelve ground scars were identified by ERI and are numbered and described in Ogden (1997). Ground Scar 1 (GS-1) was identified by ERI as a ground scar/excavation, and is described in the following subsection with the other "pit" and "excavation" features. GS-11 is the large topographic depression on the northwest side of Five Corners, and GS-12 is a clearing on the north side of Wood Road in this same area. Both GS-11 and GS-12 were investigated as part of Phase I of the IAGS, under the location name "Area 1", and are not considered further in this FSP. The other nine scars are shown in Figures 1 through 3 and described below.

GS - 2 (Photo 4): This ground scar visible in the 1943 air photo was located on the north side of Wood Road and east of Five Corners. The area is completely revegetated with trees and brush. Black ash-like stains are present on some of the trees in the area but a

# Final Phase II (a) Trenches FSP

specific burn area was not recognizable.

GS – 3 (Photo 5): This ground scar visible in the 1943 and 1955 air photos was located on the south side of Wood Road, east of GS-2. The broad, shallow topographic depression where the scar was located is completely revegetated with brush. There are no current signs of scarring or damage to vegetation in the area.

GS – 4 (Photo 6): This ground scar visible in the 1943 air photo was located on the north side of Wood Road, east of GS-3. Black ash-like stains are present on some of the older trees in the area. The area is completely revegetated with brush, and currently there is no visible sign of scarring.

GS – 5 (Photo 7): This ground scar visible in the 1943 air photo was located on the north side of Wood Road, east of GS-4. There is no current sign of scarring to the ground. Black ash-like stains are present on some of the older trees in the area. The area is completely covered with thick brush and trees.

GS – 6 (Photo 8): This ground scar visible in the 1943 and 1955 air photos was located on the north side of Wood Road, east of GS-5. The area where the scar was located is a broad, shallow topographic depression that is completely covered with vegetation. There are no signs of impact or other damage to the ground.

GS – 7 (Photo 9): GS-7 was a ground scar visible on the east side of Turpentine Road in the 1943 air photo, south of Five Corners. There is a buoy target present here with many impact craters and training rounds surrounding it. The craters lack vegetation. The entire area has thin vegetation cover relative to the surrounding area.

GS – 8 (Photo 10): This ground scar was located along the west side of Pocasset-Sandwich Road north of Five Corners, in the 1955 air photo. This location is also at the intersection of a former road leading northwest from Pocasset-Sandwich Road, and connecting with Goat Pasture Road. The vegetation in the flat area appears thinner than in the surrounding area. An old metal pipe was visible here. No other debris was observed.

GS – 9 (Photo 11): GS-9 was located along the south side of Wood Road east of Five Corners in the 1955 air photo. The former scar area is located in the base of a shallow topographic depression. The base of the depression and the western hillside contain

# Final Phase II (a) Trenches FSP



impact craters, some up to 5 feet in diameter. No training rounds were observed. The area is heavily vegetated with trees and brush, including the craters.

GS – 10 (Photo 12): GS-10 was located north of Wheelock road as seen in the 1955 air photo. The location of this apparent former scar is a large topographic depression. There is a target dart in the base of this depression. The area is densely vegetated with the exception of the base of the valley where a few small depressions that may be craters are visible. Impact craters were identified by ERI in the 1958 air photo. No training rounds were observed in the area. Soil sampling is proposed for the area surrounding the target dart, in accordance with the Final Workplan for Phase IIa Activities (Ogden, 1999a).

## 1.1.3 Description of Pits and Excavations

Pits and excavations are depressions that appear to be man made, based on ERI's interpretation of the aerial photographs. ERI did not indicate how they differentiate pits and excavations. Five pits and two excavations were identified by ERI and numbered in Ogden (1997). One of the pits (Pit-2) was located and characterized in Phase I of the IAGS, as part of "Area 3", and is not considered further in this FSP. Three of the pits (Pit-3, -4, and -5) were located at CS-19 and are not considered further in this FSP. The remaining pit and excavations are shown in Figures 1 through 3 and described below. None of the locations currently include a recognizable man made depression.

Pit – 1 (Photo 13): There is not one specific pit recognizable in the area identified by ERI in the 1951 air photo. Figure 2 shows the same area in the 1955 air photo. ERI used the notation "possible" to indicate that the feature had only a few of the typical characteristics that allow a pit to be identified by aerial photos. Currently this is a relatively low area, which is heavily cratered and littered with training rounds. The bases of the craters tend to lack vegetation. The area immediately south of the location identified by ERI was characterized in Phase I of the IAGS, as part of "Area 3".

EX – 1/ GS – 1 (Photo 14): The ground scar/excavation identified by ERI in the 1943 air photo was located on the south side of the intersection of Monument Beach and Pocasset Sandwich Roads. The area now contains trees and some slight brush. No specific excavation was observed. There are possible impact craters in the area but no training rounds were observed. Water table monitoring well MW-9S was installed at this location during Phase I of the IAGS.

# Final Phase II (a) Trenches FSP

---

EX – 2 (Photo 15): The area of the excavation identified by ERI in the 1951 air photo is now overgrown with scrub pine. Ground disturbance is visible on the 1943, 1955, and 1966 air photos (Figures 1-3). This feature was located on the east side of Pocasset-Sandwich Road, south of Five Corners. No specific excavation was observed. The area is heavily cratered and littered with training rounds. The bottom of the craters lack vegetation.

## 1.1.4 Description of Trenches

A trench is a man made excavation that is long and narrow. Most of the trenches identified by ERI in the aerial photographs are currently not identifiable in the field. Trench locations are shown in Figures 2 and 3 and described below.

TR – 2 and 3 (Photo 16): These two trenches identified by ERI in the 1963 aerial photo were located on the east side of Turpentine Road south of Five Corners. The locations are indicated in Figure 3 on the 1966 air photo. This location was investigated as part of “Area 2” in Phase I of the IAGS. The brush in this area is extremely thick and impassable. Two distinct trenches could not be distinguished but the entire area was cratered and pitted. There were many training rounds present in the area.

TR – 4 (Photo 17): This trench identified by ERI in the 1963 photo was located east of TR-2 and –3, and is also part of “Area 2” in the Phase I investigation. The locations are indicated in Figure 3 on the 1966 air photo. One specific trench is currently not distinguishable. However, in the same location, there is a broad area with many craters and distinct lack of brush. There is a tow-target present here. There are also many training rounds in the area.

TR – 5 (Photo 18): This trench identified by ERI in the 1963 air photo was located along the north side of Wheelock Road west of Turpentine Road, but is not visible now. The area is completely revegetated. Possible tank tracks were observed at this location but they were overgrown with brush and trees.

# Final Phase II (a) Trenches FSP

---

## Turpentine Road Trench

A depression was located parallel to Turpentine Road approximately 1500 feet North of the intersection of Wheelock Road. The depression and surrounding area are heavily vegetated and not visible from Turpentine Road. No debris was observed in the depression and the UXO contractor performed a quick survey with a magnetometer and detected no anomalies. This area could not be effectively photographed on the ground due to heavy growth of vegetation.

### **1.1.5 Description of Former Buildings**


This workplan is meant to address buildings in, and in the immediate vicinity of, the Impact Area, with the exception of the J Ranges as described in Section 1.0 (2nd paragraph). The only buildings in this category are the bunkers described in Section 1.1.1. The Guard proposes to address buildings associated with military ranges and training areas outside the Impact Area in the J Range workplans, Training Area workplan, and Phase II (b) workplans.

## **2.0 Proposed Soil Investigation**

The Guard proposes to conduct soil investigations at those sites identified in Section 1 where there is visible evidence suggestive of contamination, which have not been previously investigated in Phase I of the IAGS. Note that Phase I included a soil and groundwater investigation in several apparent "burn areas" (Areas 6, 7, and 8), and did not find any significant differences between these areas and other portions of the Impact Area (Ogden, 1998a). Therefore, the evidence of burning that was observed in some of the ground scars is not considered to be grounds for proposing soil investigations of these areas. Investigations are proposed for six areas where cratering and/or the presence of munitions suggest that contaminant release could have occurred. All other areas identified in this plan will be surveyed by magnetometer for potential UXO.

A groundwater investigation is not proposed for these areas at this time. Groundwater contamination in the Impact Area is being investigated in accordance with the RDX Response Plan. The Guard believes that the extensive investigation proposed in the response plan will provide the clearest indication of the potential source area(s) in the Impact Area, which is where the trenches and other features in this FSP are located.

# Final Phase II (a) Trenches FSP



## 2.1 Sampling Locations

### 2.1.1 Ground Scar 7

Ground Scar 7 is proposed for investigation based on the buoy target, craters, and munitions present at this location. Soil sampling will be conducted beginning in the area immediately surrounding the target. Contaminant concentrations are expected to be highest in this area. Samples will be arranged in concentric rings around the target, so that contaminant concentrations at varying distances can be determined. If contaminants are detected at the furthest distance sampled, additional sampling will be proposed for the target. The sampling arrangement is indicated in Figure 4.

### 2.1.1 Ground Scar 8

Ground Scar 8 is proposed for investigation based on historical aerial photographs and some scrap metal surficial material observed at this location. Two sampling grids will be located in this area, as indicated in Figure 8. One grid will be located within the GS-8 clearing, which measures approximately 50 by 100 feet in the 1955 and 1963 aerial photos. A second grid will be established surrounding the debris observed in the reconnaissance, unless the first grid covers this area in which case the second grid will be located about 100 feet west of the first grid.

### 2.1.2 Ground Scar 9

The topographic depression and its western hillside in the location of the former scar will be investigated due to the craters observed here. The proposed focal area for this feature is the western hillside that is lighter colored in the aerial photo, suggesting the greatest ground disturbance. The approximate dimensions of this focal area are 500 feet by 100 feet, or 1.1 acres. Using a sampling density of five grids per acre as was done for Phase I of the IAGS, six soil sampling grids are proposed for this area, as indicated in Figure 5. The sampling grids will be relocated in the field to include any areas of cratering or thinner vegetation.

### 2.1.3 Pit 1

Pit 1 will be investigated based on historical aerial photographs and the current heavily cratered and training-round littered topography. Two grids will be located within the

# Final Phase II (a) Trenches FSP



former circular cleared area at the location identified as a “possible pit” based on aerial photo analysis. No pit was observed in this area during the August 1999 reconnaissance. The Guard will conduct additional reconnaissance of this area by helicopter in December 1999. If no pit is observed from the airborne reconnaissance, the two grids will be placed adjacent to each other at the location indicated by the photograph. Grid locations are illustrated in Figure 9.

## **2.1.4 Excavation 2**

Excavation 2 is proposed for investigation based on the craters and training rounds present in this area. The proposed focal area for this feature is the extent of cleared area in the 1943 aerial photo, which is the largest of the areas for the years between 1943 and 1966. The approximate dimensions of this focal area are 200 feet by 130 feet, or 0.6 acres. Using a sampling density of five grids per acre as was done for Phase I of the IAGS, three soil sampling grids are proposed for this area, as indicated in Figure 6. The sampling grids will be relocated in the field to include any areas of cratering or thinner vegetation.

## **2.1.5 Bunker 1 (CS-19) and Cleared Area**

Bunker 1 and the cleared area south of it are proposed for investigation based on the activities that occurred in CS-19. The approximate dimensions of the cleared area are 85 feet by 85 feet, or 0.2 acres. Using a sampling density of five grids per acre as was done for Phase I, one soil sampling grid is proposed for this area. The sampling grid will be relocated in the field to include any areas of thinner vegetation. A sampling grid will also be located above/behind (north of) the bunker, where munitions and other debris are visible. A composite soil sample will also be collected from the dirt floor of the bunker. This will be a composite of at least three locations on the floor, designed to be representative of the total area of dirt. Each subsample will be collected from 0-3 inches, unless a barrier (flooring material) is present in which case the sample will not be advanced below the barrier. Sampling locations are indicated in Figure 7.

## **2.2 Sampling & Analysis Methods for Soils**

Soil sampling grids measuring 22 x 22 feet will be used for sampling GS-8, GS-9, Pit-1, EX-2, and BK-1. Individual subsampling points for the five-point grids are illustrated in Figure 10. Each five-point grid will have all five subsamples separately homogenized

## Final Phase II (a) Trenches FSP

---

and split into two subsamples, one used for the grid composite and the other analyzed as a discrete sample. The sampling intervals will be 0-6 and 18-24 inches bgs. Additional sampling at depth will be dependent upon the results of the surface soil samples and will be discussed with the USEPA and MADEP on a case by case basis. Soil subsamples will be wetted using deionized water as needed to prevent observable dust emissions during the composite mixing process.

Two rings of samples will be placed around the target at GS-7, at radii of 10 feet and 20 feet from the center of the buoy. Each ring will have 8 evenly distributed subsamples separately homogenized and four points where discrete samples are taken, split into two subsamples, one used for the ring composite and the other analyzed as a discrete sample. The sampling arrangement is indicated in Figure 4. Each of the subsamples in a ring will be composited to provide one concentration of possible contaminants in soil of equal distance from the target. The discrete samples will be located where the north, south, east and west axes of the target intersect the rings. Sampling depths are 0-6 and 18-24 inches bgs.

Sample collection will be consistent with MMR SOPs, the Ogden Health and Safety Guidelines, Attachment C: Field guide to High Explosives, Attachment D: Soil Sampling Protocol, and the ASTM Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities (October 31, 1996). Sampling grids and rings will be flagged for magnetic anomalies prior to sampling, and sampling points adjusted if necessary to avoid anomalies. EPA Method 8330 will be used to analyze all samples.

The following protocol will be followed for soil sampling:

1. A 0-6" soil sample will be collected from each of the five sample points in a grid using the method described in Attachment D, resulting in five subsamples per grid. For each ring at GS-7 eight subsamples will be collected.
2. Each subsample will be homogenized, wetting as needed to prevent dust emission. For the four subsamples in each ring where it is necessary to collect a discrete sample, the homogenized subsample will be split into two subsamples in accordance with Section 8.1 of the ASTM Standard Guide and Attachment C of this FSP, resulting in four pairs of subsamples;
3. The subsample or split from each point will be combined in equal amounts with the other subsamples or splits in the grid to comprise a single composite sample, in

# Final Phase II (a) Trenches FSP



accordance with Section 8.1 of the ASTM Standard Guide and Attachment C of this FSP. Discrete subsamples from the rings will also be submitted for analysis.

4. Repeat steps 2-3 above for the 18-24" depth interval for each grid and ring.

In addition to field samples, QA/QC samples will be collected as described in the QA/QC Plan (Ogden, 1999c). These include field duplicates at the rate of 10% (rounded to the next whole number) of the field samples, trip blanks at the rate of 1 per day per sampling crew, field blanks at the rate of one per sampling event per water source, and equipment rinsates at the rate of 1 per day.

## 3.0 Sample Identification

Samples will be uniquely identified with a sample ID that contains a reference to the sample location and the sample depth. The following is an example of the sample ID:

HC90A1AAA

The sample ID is broken down in the following example, to describe each of the components:

HC – 90 – A - 1 - AA - A

HC	Indicates that the sample being collected is a hand auger composite sample (HD is used for hand auger discrete samples)						
90	Indicates the Area from which the sample was collected (90 = GS-7, 91 = GS-8, 92 = GS-9, 93 = Pit 1, 94 = EX-2, 95 = BK-1)						
A	Indicates the grid location for square grids (see Figures 5-9), or for rings indicates the ring distance (A is the innermost ring, B is the next outer ring, etc.)						
1	Denotes subsample location = 1 for composite sample. For rings with discrete samples, 1 is the north subsample, 2 is the northeast subsample, 3 is the east subsample, etc.						
AA	Indicates the depth from which the sample was collected where "AA" is the first depth (0-6 inches bgs), and "BA" is the second depth (18-24 inches bgs)						
A	Indicates the type of sample. <table><tr><td>A</td><td>Original Sample</td></tr><tr><td>D</td><td>Duplicate Sample</td></tr><tr><td>E</td><td>Equipment Rinsate</td></tr></table>	A	Original Sample	D	Duplicate Sample	E	Equipment Rinsate
A	Original Sample						
D	Duplicate Sample						
E	Equipment Rinsate						

# Final Phase II (a) Trenches FSP

F      Field Blank  
T      Trip Blank

For example, HC90A1AAA is a hand auger composite sample from GS-7 grid A (innermost ring), from 0-6 inches bgs.

## 4.0 References

ETA, 1997. Final Action Plan for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Engineering Technologies Associates, Inc., Ellicott City MD, July 1997.

Ogden, 1997. Draft Range Use History Report of the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, July 1997.

Ogden, 1998. Draft Completion of Work Report for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 7/1/98.

Ogden, 1999a. Final Workplan for Phase II (a) Activities for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 07/21/99.

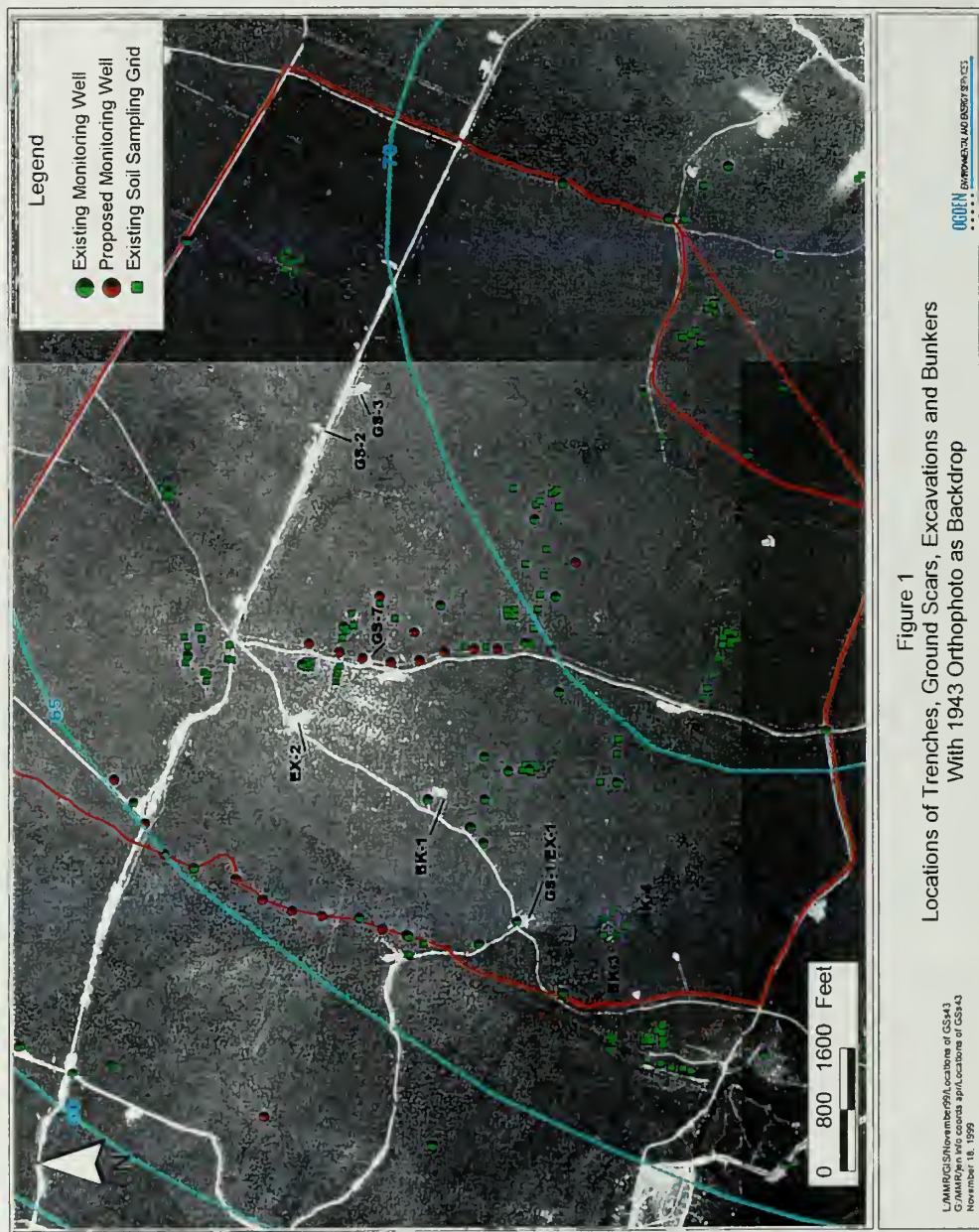
Ogden, 1999b. Draft Training Areas Workplan for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 07/23/99.

Ogden, 1999c. Quality Assurance/Quality Control Plan Addendum of the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 04/14/99.

Ogden, 1999d. Draft Phase II (a) Response Plan for Impact Area RDX Detections in Groundwater for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 08/23/99.

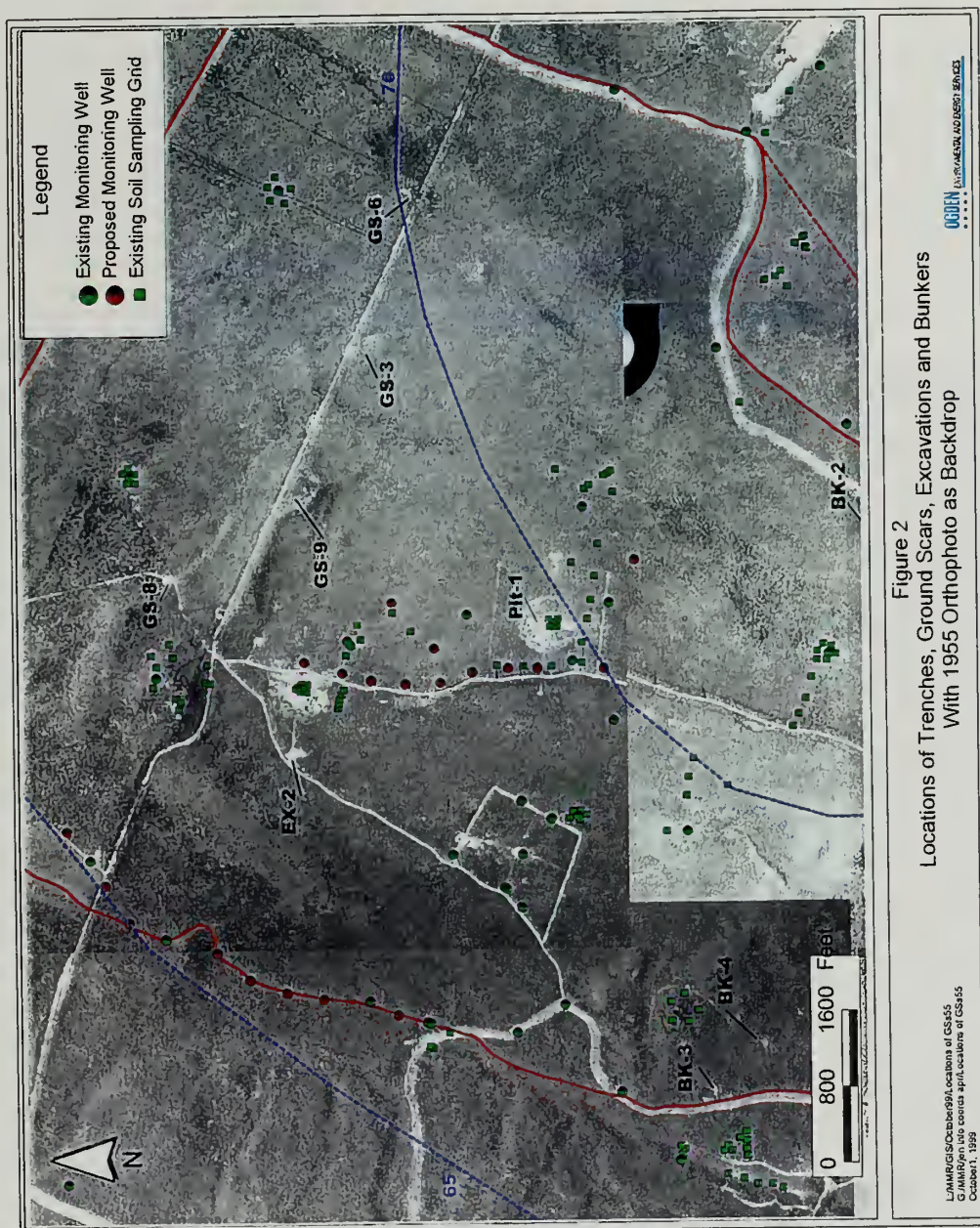
# Final Phase II (a) Trenches FSP

Figure 1. Locations of Trenches, Ground Scars, Excavations, and Bunkers with 1943 photo.



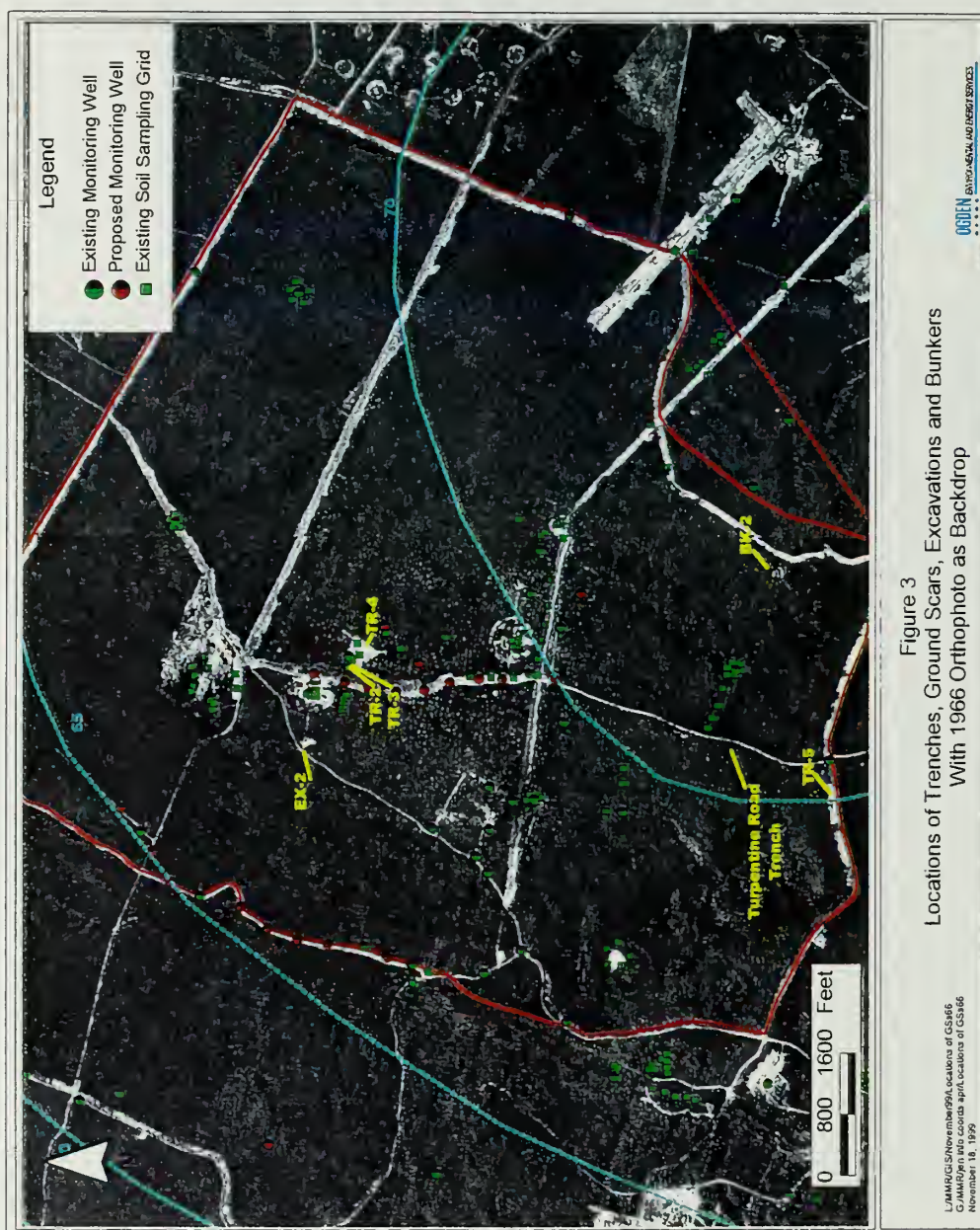
# Final Phase II (a) Trenches FSP

Figure 2. Locations of Trenches, Ground Scars, Excavations, and Bunkers with 1955 photo



# Final Phase II (a) Trenches FSP

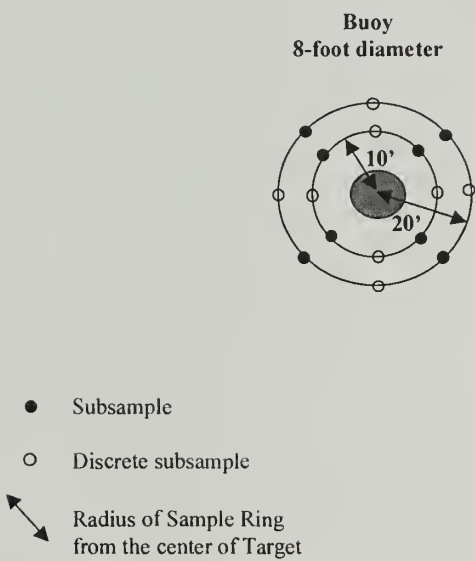
Figure 3. Locations of Trenches, Ground Scars, Excavations, and Bunkers with 1966 photo



# Final Phase II (a) Trenches FSP

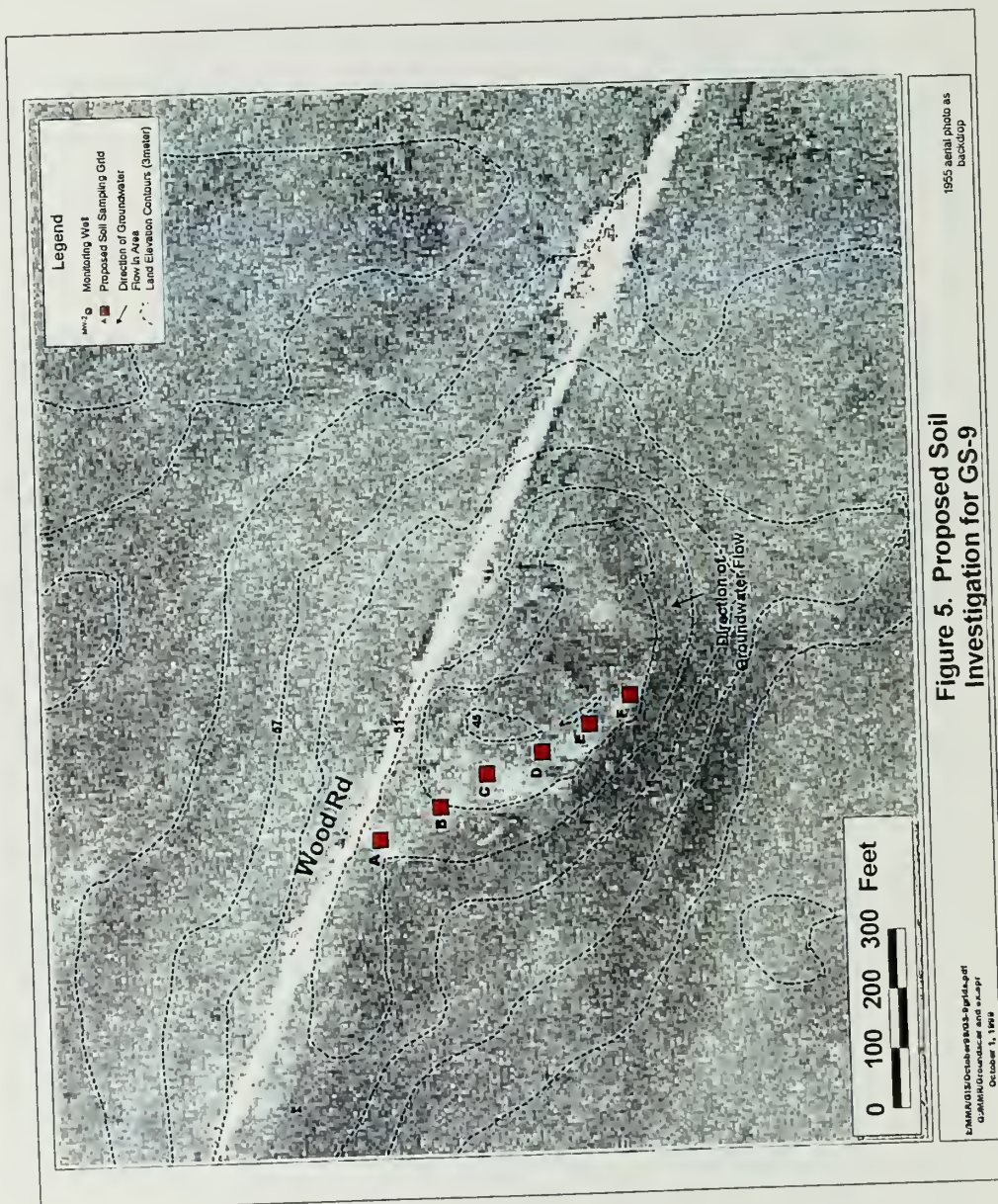


**Figure 4**  
**Soil Sampling Arrangement at Target Buoy (GS-7)**



# Final Phase II (a) Trenches FSP

Figure 5. Proposed Soil Investigation for GS-9



# Final Phase II (a) Trenches FSP

Figure 6. Proposed Soil Investigation for EX-2

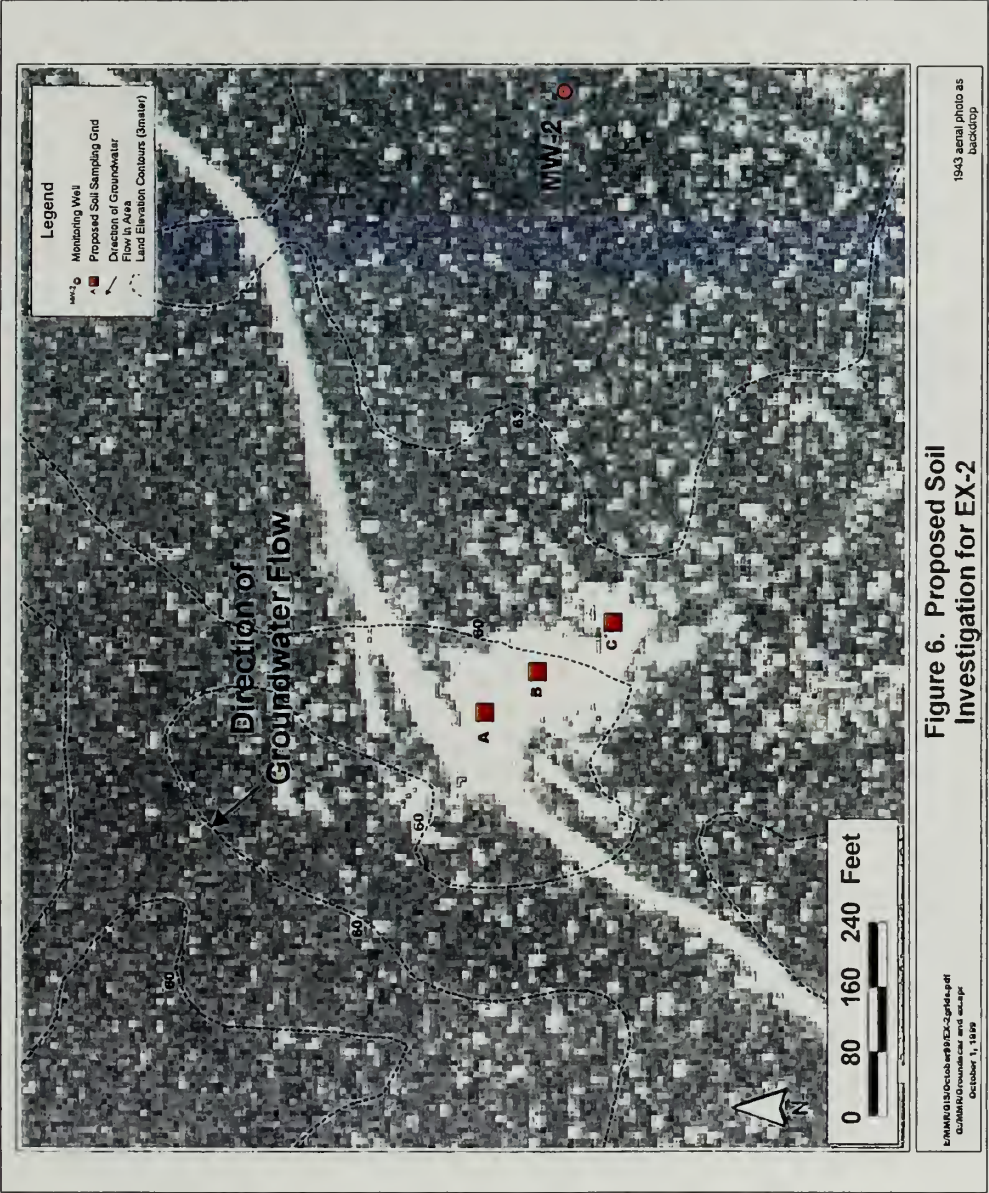
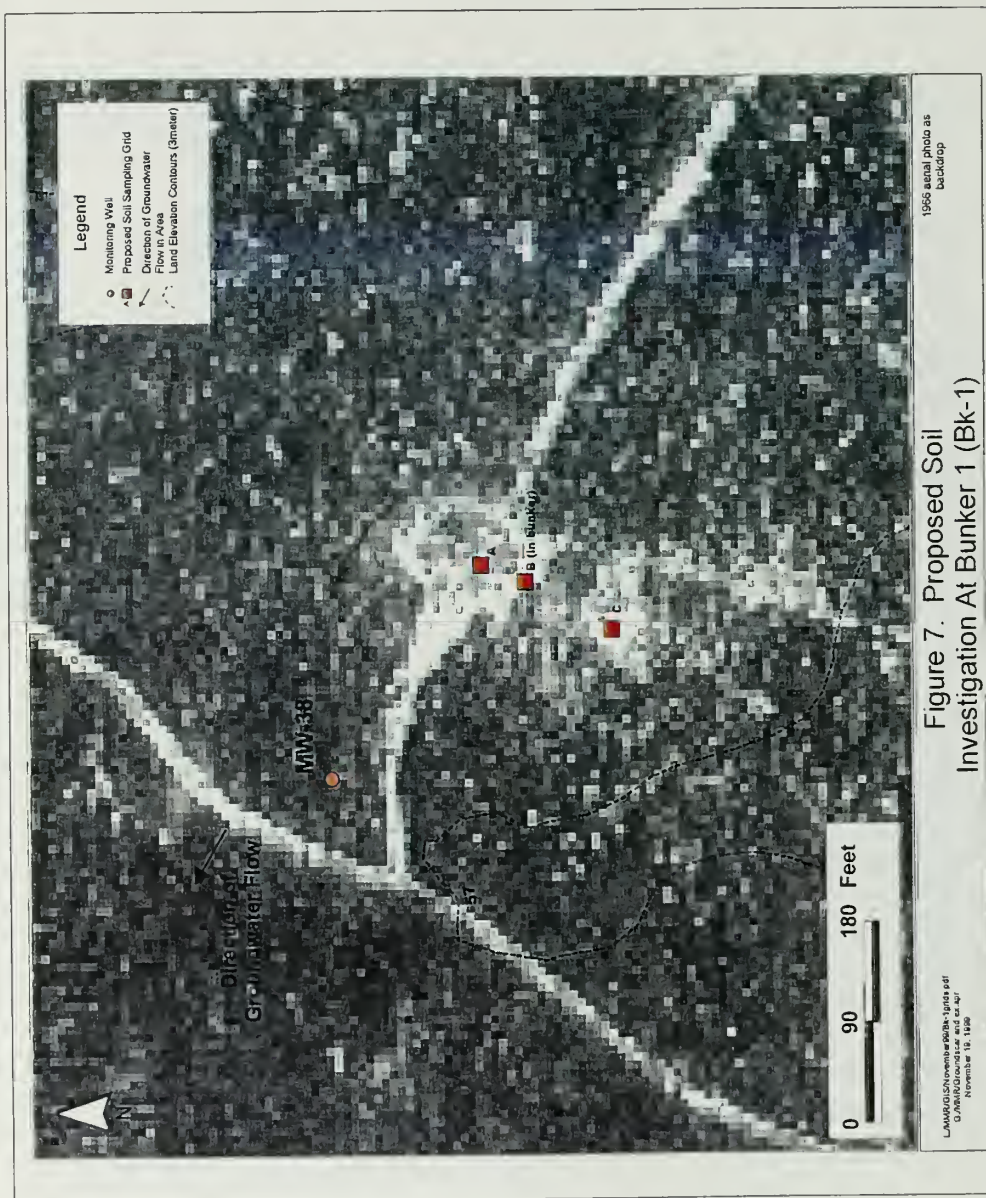


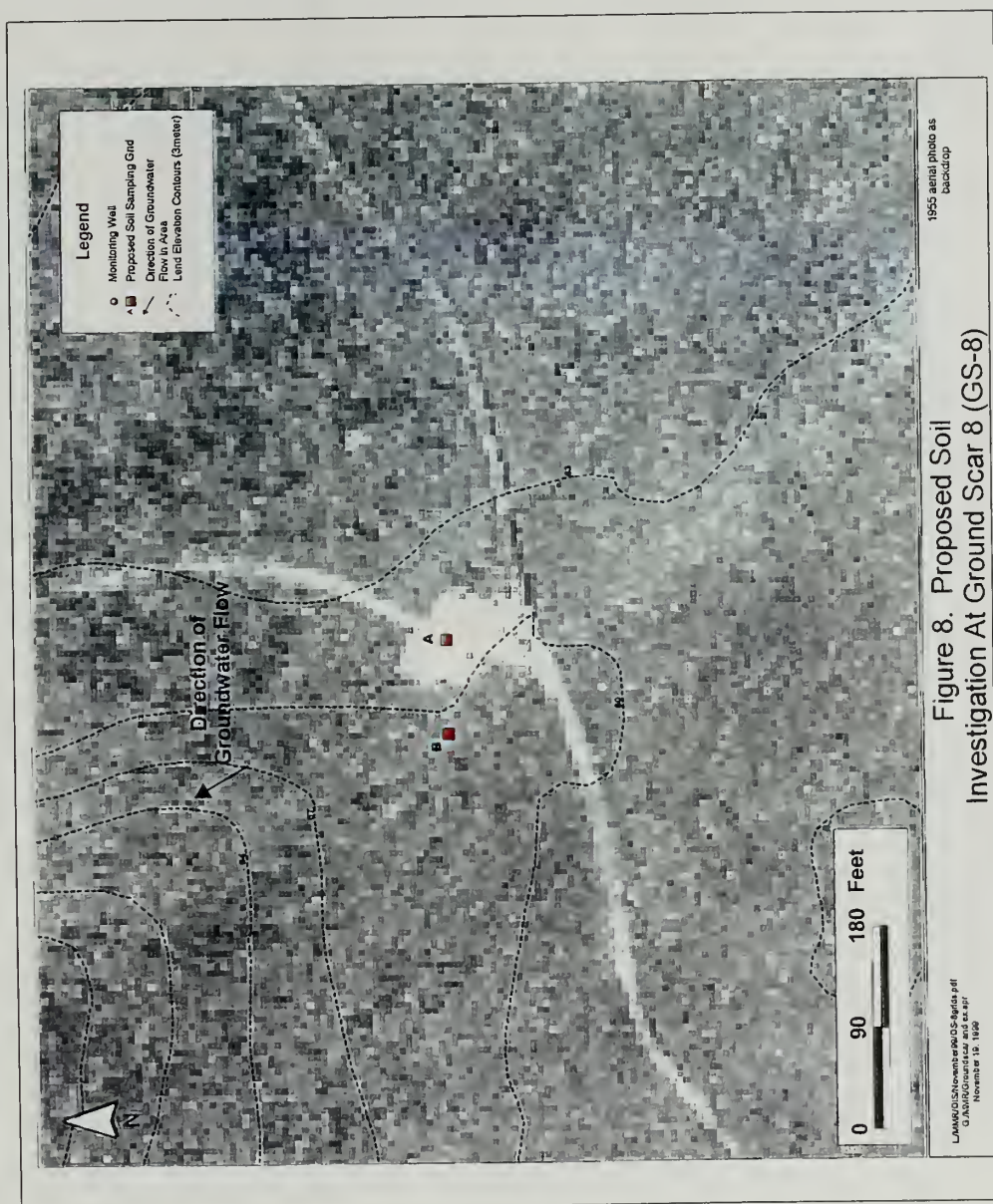



Figure 7. Proposed Soil Investigation at BK-1.



# Final Phase II (a) Trenches FSP

Figure 8. Proposed Soil Investigation at GS-8.



# Final Phase II (a) Trenches FSP

Figure 9. Proposed Soil Investigation at Pit 1.

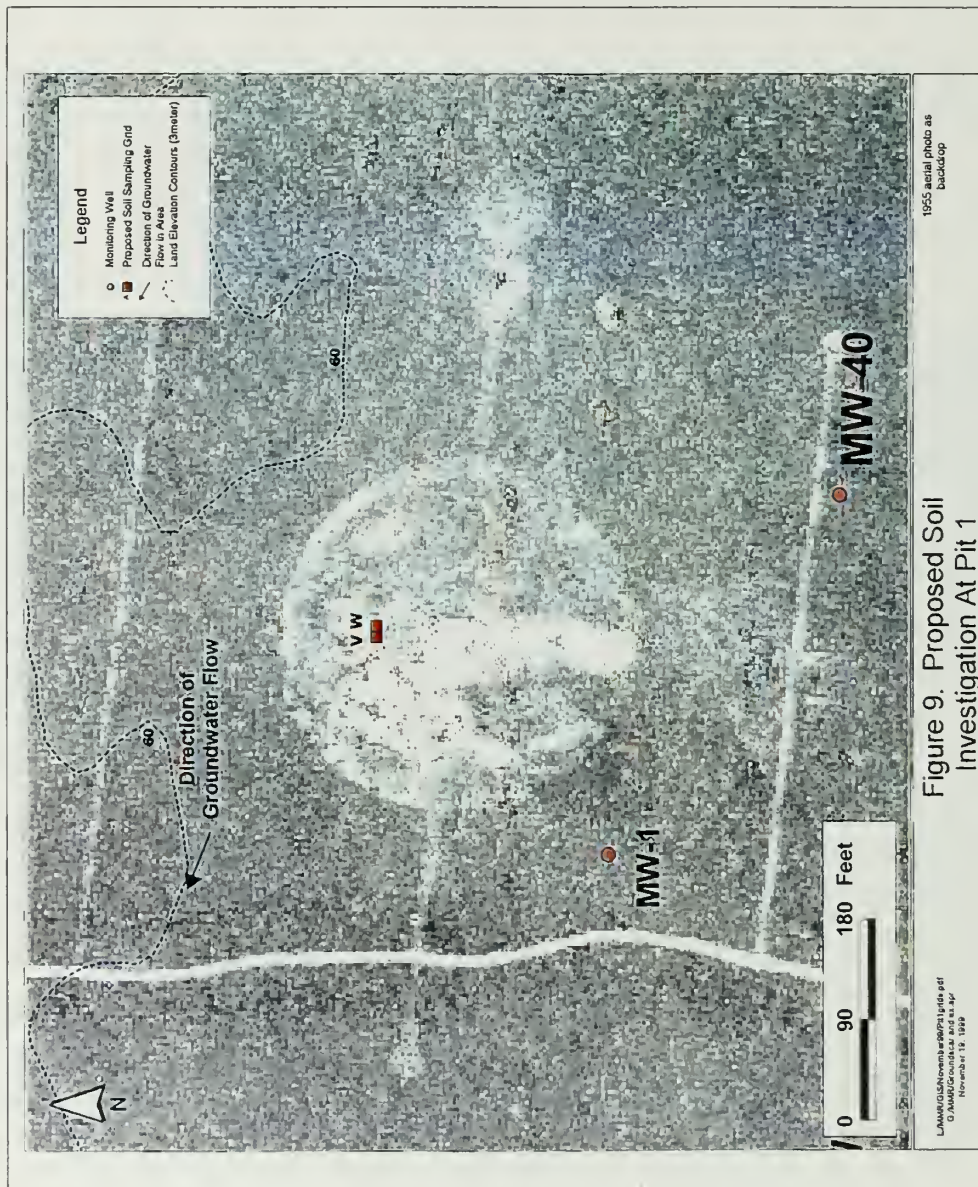


Figure 9. Proposed Soil Investigation At Pit 1

# Final Phase II (a) Trenches FSP

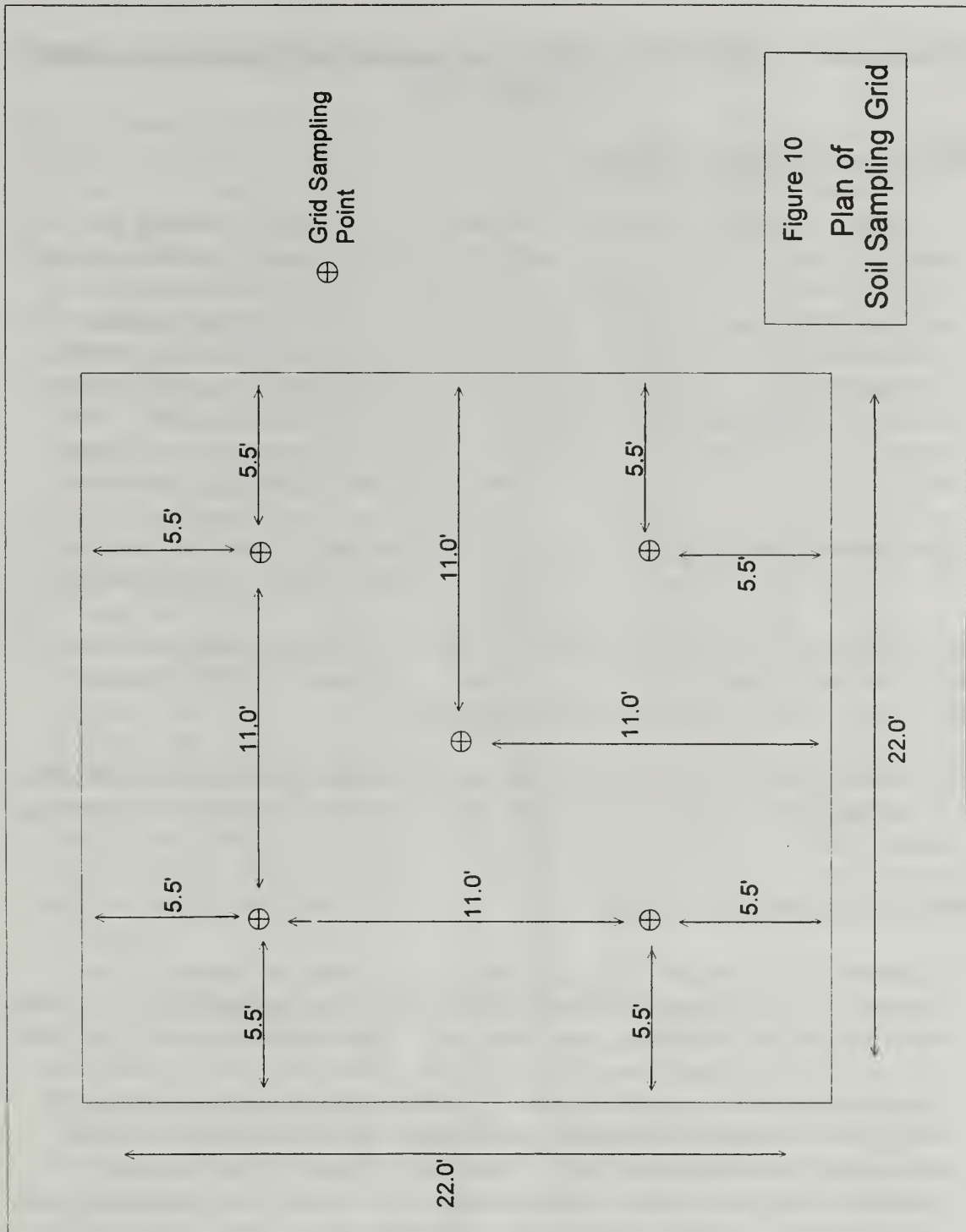


Figure 10  
Plan of  
Soil Sampling Grid

# Final Phase II (a) Trenches FSP

## Attachment A. Regulatory Agency Comments and Responses on Draft Trenches FSP

### EPA General Comments (11/2/99):

1. As discussed during the 28 October 1999 weekly IAGS Technical Meeting, the bunker referred to in this work plan as BK-1, is to be investigated by NGB as part of the IAGS, and not AFCEE as part of the Installation Restoration Program (IRP). In addition, EPA requests NGB investigate and sample a cleared area approximately 100 feet south of BK-1, evident in the 1955 and 1966 aerial photographs. This investigation is to include, at a minimum, UXO clearance of BK-1 and the immediate area, UXO clearance of the cleared area observed in 1955 and 1966 aerial photographs, and at least one soil sampling grid at each of these locations. Since these locations appear to have been disturbed previously, soil samples should be collected from five-point grids at 0 to 6 inch, and 18 to 24 inch depths (as is currently planned for soil sampling at the Gun and Mortar positions). If BK-1 contains a dirt floor, at least one (1) discrete soil sample is to be collected from inside this bunker.

*Change pages to show the additional investigations at the bunker and the cleared area south of the bunker were provided to the regulatory agencies on 11/18/99. Section 2.2 will be revised to indicate the change in sampling depths.*

In addition, please amend the text in Sections 1.0 on Page 1 and Section 1.1.1 on Page 3 which indicate that BK-1 is being investigated as part of the IRP CS-19 Remedial Investigation.

*The text will be revised as requested.*

2. In Section 2.0, it states that "The Guard proposes to conduct soil investigations at those sites . . . where there is visible evidence suggestive of contamination . . .". This effectively avoids investigating most areas, as all appear to be overgrown. This plan does not satisfy the requirements of EPA's 17 July 1997 letter which requested the "characterization of the nature and extent of contamination (including sampling of soils, groundwater, and as appropriate, sediments) at former and current trenches, excavations, bunkers, and buildings". Therefore, EPA partially approves this workplan, under the condition that this provides a first phase to this requirement, with

## Final Phase II (a) Trenches FSP

additional investigations to be included at a later date.

*The condition of "additional investigations to be included at a later date" was discussed with EPA on 11/4/99. The criteria for additional investigations were described as detections in the proposed investigations, and/or results of magnetometer surveys (see response to last paragraph of this comment). The Guard agrees to the condition of additional investigations using these criteria.*

According to the NGB (16 June 1999 IAGS Fact Sheet), explosive contamination in groundwater at MMR may be the result of improper disposal of ordnance, as opposed to residues from approximately 60 years of artillery training. Given this argument, it would appear to be in the interest of NGB to more intensively investigate trenches, pits, excavations, and ground scars (or any other area where disposal may have occurred), than currently proposed in this plan.

*Groundwater contamination in the Impact Area is being investigated in accordance with the RDX Response Plan. The Guard believes that the extensive investigation proposed in the response plan will provide the clearest indication of the potential source area(s) in the Impact Area, which is where the trenches and other features in this FSP are located.*

EPA requests NGB re-examine each of the features discussed in this plan. At a minimum, this is to include UXO clearance of each area with a low-technology magnetometer survey (Schonstedt, Mark-26, or other) to determine surficial UXO and investigate the potential presence of large anomalies in shallow sub-surface soils. In specific comments below, EPA requests that three additional features (for a total of 6 features total) be sampled (in addition to UXO surveyed as above). EPA reserves the right to propose additional investigations, based on the results obtained during this fieldwork.

*The requested UXO surveys will be performed. See responses to specific comments regarding additional investigations.*

3. This plan does not address the location of former buildings. At a minimum, a "Section 1.1.5 - Buildings" should be added, and language should be included as to the location of current/former buildings, if any. EPA points out that several buildings were formerly located south of Dolan Road, south of the Former G Range (Distance Rifle Range). It may be more appropriate to investigate this area as part of Phase II

## Final Phase II (a) Trenches FSP

(b) activities; however some text should be included here. In addition, were historical maps consulted for former locations of other buildings? This work plan is by no means complete if the general category of “buildings” is used. If this workplan is meant to address current/former buildings in, and in the immediate vicinity of, the Impact Area, this should be explicitly stated in the text.

*This workplan is meant to address current/former buildings in, and in the immediate vicinity of, the Impact Area, with the exception of the J Ranges as described in Section 1.0 (2<sup>nd</sup> paragraph). The only buildings in this category are the bunkers described in Section 1.1.1. The text will be revised as requested to clarify the scope of the FSP. The Guard proposes to address buildings associated with military ranges and training areas outside the Impact Area in the J Range workplans, Training Area workplan, and Phase II (b) workplans.*

### **EPA Specific Comments (11/2/99):**

1. Page 4, GS-8 (Photo 10) – EPA requests that this former ground scar location be sampled, based on historical aerial photographs and some scrap metal surficial material observed at this location. Although GS-8 is a small cleared area in the 1955 aerials, it is part of a much larger cleared area in the 1966 aerials. EPA requests a minimum of two (2) grids be established in this location.

*The suggested investigations will be added. One grid will be located within the GS-8 clearing, which measures approximately 50 by 100 feet in the 1955 and 1963 aerial photos. A second grid will be established surrounding the debris observed in the reconnaissance, unless the first grid covers this area in which case the second grid will be located about 100 feet west of the first. Both grids are within the apparent clearing in the 1966 aerial photo, otherwise known as GS-11 and characterized as Area 1 in Phase I of the IAGS.*

2. Page 5, Pit-1 (Photo 13) – EPA requests that this former pit be sampled, based on historical aerial photographs and the current heavily cratered and training-round littered topography. EPA requests a minimum of two (2) grids be established at this location.

*The suggested investigations will be added. Two grids will be located within the former circular cleared area at the location identified as a “possible pit” based on aerial photo*

## Final Phase II (a) Trenches FSP

*analysis. No pit was observed in this area during the August 1999 reconnaissance. The Guard will conduct additional reconnaissance of this area by helicopter in December 1999. If no pit is observed from the airborne reconnaissance, the two grids will be placed adjacent to each other at the location indicated by the photograph. The former circular cleared area was characterized as part of Area 3 in Phase I of the IAGS.*

3. Page 6, Section 1.1.14 -- For TR-5, the approximate location should be indicated on either Figure 2 or 3, as appropriate.

*The figure will be revised as requested.*

4. Page 6, TR-5 (Photo 18) – EPA believes a trench currently exists west of Turpentine Road and north of Wheelock Road. This trench is separate, and south of, the location which is currently referred to as the “Slit Trench”, to be investigated as part of the MMR Munitions Survey Plan. EPA requests that this feature be further investigated and, based on the field reconnaissance and subsequent discussions with EPA and MA DEP, possibly sampled.

*A reconnaissance of this area was conducted on 11/10/99. Change pages describing the trench were provided to the regulatory agencies at the 11/18 technical meeting.*

5. Pages 11-13, Figures 1-3 – Please indicate the location of BK-1 and the cleared area to the immediate south of BK-1 which are to be sampled as part of this plan.

*The location of the cleared area at BK-1 has been labeled on Figure 1. The location of the Turpentine Road trench (see specific comment 4) has been added on Figure 3.*

6. Page 8, Section 2.2 – EPA requests that all soil sampling grids established as part of this field sampling plan have samples collected at the 0-6 and 18-24 inch depth intervals, to be consistent with IAGS soil sample collection in other disturbed areas.

*The text will be revised as requested.*

7. Page 16 – Please update the figures section to include all of the locations requested above.

*New Figures 7, 8, and 9 have been inserted to show the position of soil sampling grids in*

# Final Phase II (a) Trenches FSP



*the cleared area south of BK-1, at GS-8, and at Pit-1, respectively. Existing Figure 7 has been relabeled Figure 10.*

## MADEP General Comments (11/9/99)

1. The Department understands that the NGB and the Air Force Center for Environmental Excellence ("AFCEE") have agreed that the NGB will include investigations associated with Bunker 1 ("BK-1") and two disturbed areas immediately south of BK-1 in a revision of this FSP. The agreement was reached at a meeting between the Department, EPA, AFCEE, and the NGB on Thursday, October 28, 1999. These locations were previously considered as part of the CS-19 study area, a former disposal area where the AFCEE is conducting soil and groundwater investigations under the Installation Restoration Program ("IRP"). The Department anticipates that proposed investigations associated with BK-1 and the two cleared areas south of it will be provided to the Department and the EPA for review and comment prior to finalization of this FSP.

*Change pages to show the additional investigations at the bunker and the cleared area south of the bunker were provided to the regulatory agencies on 11/18/99.*

2. Please indicate within the text of the FSP why groundwater investigations have not been proposed. Please also include either water table contours or groundwater flow direction arrows on appropriate figures.

*The text and figures will be revised as requested. Groundwater contamination in the Impact Area is being investigated in accordance with the RDX Response Plan. The Guard believes that the extensive investigation proposed in the response plan will provide the clearest indication of the potential source area(s) in the Impact Area, which is where the trenches and other features in this FSP are located.*

3. The title of the FSP indicates that it includes "**Former Buildings**". However, no former buildings are identified or otherwise included in the FSP. Please clarify.

*This workplan is meant to address current/former buildings in, and in the immediate vicinity of, the Impact Area, with the exception of the J Ranges as described in Section 1.0 (2<sup>nd</sup> paragraph). The only buildings in this category are the bunkers described in Section 1.1.1. The text will be revised as requested to clarify the scope of the FSP. The*

# Final Phase II (a) Trenches FSP

*Guard proposes to address buildings associated with military ranges and training areas outside the Impact Area in the J Range workplans, Training Area workplan, and Phase II (b) workplans.*

## **MADEP Page-Specific Comments**

### **1. Page 3, Section 1.1.1 Description of Bunkers**

For completeness, the Department suggests soil sampling from at least one of the four Bunkers indicated in this section. Please include in the FSP addendum that addresses proposed sampling for BK-1 at CS-19, at a minimum.

*See the response to MADEP General Comment 1.*

Bunker 2, described under the sub-heading “**BK-2 (photo 1)**” is denoted as not providing a view of any target areas, and facing north. Given its orientation and lack of targets within viewing distance, the former purpose of BK-2 is not immediately obvious. Please clarify.

*This bunker may have provided a view of the targets along Tank Alley or the end of the 2,000-meter J-1 Range, both located to the north.*

### **2. Page 7, Section 2.1 Sampling Locations**

The Department concurs with the sampling locations identified within this section, with the understanding that additional soil sampling at other locations initially not selected from **Table 1, Summary of Feature Types and Locations**, (page 2) and described in this FSP, may be revisited in a follow-on FSP.

*The Guard understands that additional investigations may be required based on the results of the proposed work, or the results of other investigations. See also the response to EPA General Comment 2.*

### **3. Page 11, 12, and 13: Figures 1, 2, and 3 ... Locations of Ground Scars, Excavations and Bunkers... (1943, 1955, and 1966 Orthophoto as Backdrop, respectively)**

## Final Phase II (a) Trenches FSP

---

Each of these Figures includes symbols that are identified as locations of **“Proposed Monitoring Wells”** in the Legend. Although these wells are not referenced in the text of the FSP, the Department assumes they represent the well locations proposed in the NGB’s September 23, 1999 document entitled **“Phase II (a) Response Plan for Impact Area RDX Detections in Groundwater”** (the “RDX Response Plan”). It is the Department’s understanding that the locations of the RDX Response Plan wells have not been finalized. Please revise the text and/or figures of the FSP to clarify the purpose of the proposed wells shown on these three figures.

*The text will be revised as requested.*

# Final Phase II (a) Trenches FSP

## Attachment B. Photographs of Reconnaissance Locations

Photo 1: Bunker 2



Photo 2: Bunker 3



Photo 3: Bunker 4



Photo 4: GS-2



Photo 5: GS-3



Photo 6: GS-4



## Final Phase II (a) Trenches FSP

\*\*\*\*\*

Photo 7: GS-5



Photo 8: GS-6



Photo 9: GS-7



Photo 10: GS-8



Photo 11: GS-9



Photo 12: GS-10



# Final Phase II (a) Trenches FSP

Photo 13: Pit-1



Photo 14: EX-1/GS-1



Photo 15: EX-2



Photo 16: TR-2/3



Photo 17: TR-4



Photo 18: TR-5



## Final Phase II (a) Trenches FSP

Photo 19: CS-19 Former Cleared Area



Photo 20: Bunker 1 (CS-19)



# Final Phase II (a) Trenches FSP



## Attachment C: Field Guide to High Explosives

**Any substance encountered during sampling activities which differs in any way from natural media will be treated as a dangerous substance, carefully removed from the sample, and set aside.**

### EXPLOSIVES

<u>NAME</u>	<u>DESCRIPTION</u>	<u>REMARKS</u>
BLACK POWDER	BROWN TO BLACK	MANUFACTURED IN GRAINS THAT RANGE IN SIZE FROM SMALLER THAN SALT GRAINS TO GRAINS AS LARGE AS SMALL PEBBLES. HIGHLY SENSITIVE TO IGNITION BY HEAT, FRICTION, FLAME, SPARK. WHEN WET, IT IS CORROSIVE TO MOST METALS.
TNT	LIGHT YELLOW TO BROWN OR GRAY	LIGHTLY CORROSIVE WITH LEAD. USED IN BOMBS, GRENADES, DEMOLITION CHARGES, PROJECTILES. EXUDES AT ELEVATED TEMPERATURES. MODERATELY TOXIC BY SKIN ABSORPTION OR INHALATION.
EXPLOSIVE D	BRIGHT YELLOW TO ORANGE. ALSO CALLED AMMONIUM PICRATE.	RELATIVELY INSENSITIVE. HIGHLY TOXIC BY INHALATION, INGESTION, OR SKIN ABSORPTION
AMATOL	LIGHT BROWN TO YELLOW/MIXTURE OF TNT AND EXPLOSIVE D	SLIGHT HYGROSCOPIC. HAS CORROSIVE EFFECTS ON COPPER, BRONZE, LEAD, BRASS. HIGHLY TOXIC BY INHALATION SKIN CONTACT, INGESTION.
COMPOSITION B	WHITE TO BROWNISH YELLOW, MIXTURE OF TNT AND EXPLOSIVE D	SLIGHTLY CORRODES COPPER, BRASS, CADMIUM, ZINC. USED IN BOMBS, PROJECTILES, GRENADES, SHAPED CHARGES.
OCTOL	LIGHT BROWN	USED IN BOMBS, PROJECTILES, SHAPED CHARGES.
RDX	WHITE. ALSO CALLED CYCLONITE	SENSITIVE TO IMPACT AND FRICTION SLIGHTLY CORROSIVE WITH COPPER, BRASS, MILD STEEL, CADMIUM MODERATELY TOXIC BY INHALATION OR INGESTION

# Final Phase II (a) Trenches FSP



## EXPLOSIVES, continued

<u>NAME</u>	<u>DESCRIPTION</u>	<u>REMARKS</u>
HMX	WHITE. ALSO CALLED OCTOGEN	SENSITIVE TO IMPACT AND FRICTION. SLIGHTLY TOXIC.
PETN	WHITE	SENSITIVE TO IMPACT. SLIGHTLY CORROSIVE TO BRASS, CADMIUM, ZINC. VERY SLIGHTLY TOXIC.
LEAD AZIDE	WHITE TO LIGHT BROWN	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO COPPER, ZINC. VERY SLIGHTLY TOXIC.
LEAD STYPHNATE	LIGHT ORANGE TO REDDISH BROWN	SAME AS LEAD AZIDE.
MERCURY FULMINATE	GRAYISH	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO ALUMINUM, MAGNESIUM, BRONZE, COPPER, ZINC, BRASS. HIGHLY TOXIC THROUGH SKIN ABSORPTION, INHALATION, INGESTION. SYMPTOMS RESEMBLE MERCURY POISONING.

## PYROTECHNIC AGENTS USED AT MMR

<u>SYMBOL</u>	<u>COMMON NAME</u>	<u>VISUAL IDENTIFICATION</u>	<u>ACTION</u>
CS	NONE	WHITE CRYSTALLINE SOLID	TEAR AGENT
HC	HEXACHORO-ETHANE	WHITE SOLID	SCREENING SMOKE
WP	WHITE PHOSPHOROUS	PALE YELLOW SOLID	SCREEN SMOKE AND INCENDIARY
RP	RED PHOSPHOROUS	REDDISH BROWN POWDER	SCREENING SMOKE

# Final Phase II (a) Trenches FSP



## OTHER COMPOUNDS

NAME	PROPERTIES	STABILITY
Picric Acid	lemon-yellow crystalline solid	very sensitive to blows or friction
Tetryl	fine yellow crystalline powder	sensitive to blows or friction
Composition A	white, >90% RDX	very sensitive to blows or friction
Composition C3	unknown	unknown
Composition C4	white, >90% RDX	very sensitive to blows or friction
Pentolite (50/50)	yellow-white, TNT/PETN	unknown
Tracer Compound	Potassium perchlorate	unknown
PBX	Plastic Bonded Explosive	unknown
Ednatol	yellow cast explosive, EDNA/TNT	medium sensitivity
Tetrytol	light yellow to buff, TNT/Tetryl	sensitivity > TNT, < tetryl

# Final Phase II (a) Trenches FSP



## Attachment D. Soil Sampling Protocol

### Sampling for Explosives

- The split barrel sampler will be decontaminated following the procedures outlined in SOP "MMR TECH-036".
- The split barrel sampler will be hammered to the desired depth using the slide hammer.
- The sampler will be retracted from the hole and detached from the hammer.
- The core tip and hammer cap will be unscrewed from the split tube.
- The split tube will be opened and samples will be transferred to a headspace container and a decontaminated stainless steel bowl for preparation of composite samples.
- The split barrel sampler will be decontaminated prior to the collection of additional samples.
- If refusal is encountered with the split barrel sampler, an attempt to collect the sample with a hand auger will be made.
- The split barrel sampler will be used for the collection of laboratory samples only. If there is an interval in the boring that will not be laboratory analyzed, then that interval will be removed using a decontaminated hand auger.

JONATHAN BOURNE PUBLIC LIBRARY



0 0113 0096918 2

13636

ADW0079

Jonathan Bourne Public Library  
19 Sandwich Rd.  
Bourne, MA 02532

**For Reference**

**Not to be taken from this room**



mmr - 0553